Life Cycle Cost Analysis for the Show Dome Renovation Options

On the following page a life cycle cost analysis spreadsheet is presented for the five proposed renovation options for the Show Dome. The analysis starts with the conceptual estimates of the total project costs for each of the renovation options, and is shown on the spreadsheet as the Initial Capitol Cost. The analysis uses a study period of 40 years and is divided into 5-year periods. Future expenses are identified as:

- heating and ventilating costs,
- maintenance costs,
- façade repair costs,
- concrete repair costs, and
- equipment replacement costs.

Heating and ventilating costs are the estimated costs for electricity and fuel to operate the Show Dome for 5-year periods. Maintenance costs are the estimated costs to wash the glazing once every 5 years. Façade repair costs include the estimated costs to replace broken glass and clean the drainage systems once every 5 years. Concrete repair costs are the estimated costs to clean, repair and paint the concrete frame once every 20 years. Equipment replacement costs are the estimated costs to replace mechanical system components at the end of their life expectancy.

The life cycle cost analysis spreadsheet presented utilizes a real discount rate of 3%. The analysis does not include financing costs for the initial renovations, and also does not include a residual value of the Show Dome at the end of the selected 40 year study period.

Show Dome Façade Study

Façade Maintenance System Option

The Mitchell Park Domes have suffered from a lack of maintenance on the glazing system for many years. The main reason is the difficulty of reaching the glass surface, whether inside or outside. Previously, boom/bucket lifts of sufficient reach were simply not available for rental or purchase. In recent years, long reach lifts have become available and could potentially be used now to effectively reach broken panels of glass for replacement.

For the interior, long reach lifts can fit through the doors, but movement inside the Domes and access to any part of the interior is challenged by the existing plant materials and interior structures.

On the exterior, long reach booms are now available, although the landscaping and buildings around the various domes makes it difficult for the boom-lifts to reach close enough to the dome base. For this reason a boom lift is not considered to be the best solution. The best solution therefore may be to provide a maintenance cart capable of climbing over the dome glazing system while providing a horizontal platform at all times for staff to work on. Refer to the sketches presented at the end of this report in Appendix C.

a. The basic idea is to have cables attached to a single swivel anchor point located at the apex of the dome. The cables would stay permanently in place, and when not in use, would be attached to the bottom of the dome, at a non-exposed place. There would be two independent sets of cables anchored on the same apex. Each set would consist of traction cables (presumably sheathed 1/4" stainless steel wire rope) and two cables for workers' safety.

b. A single movable specialty work cart would be manufactured of all aluminum. The cart would be approximately 10 feet wide by 9.5 feet long (center of wheels). The cart would have a work platform of sufficient size for two workers, tools and replacement glass units.

c. The cart would be brought to a point close to the base of the dome, preferably in line with the pane of glass to be replaced. The traction cables would be attached to individual winches (total of 2) on the cart through wire guides. Upon starting the winches, the cart would pull itself up the dome structure. Winch controls would be attached to the cart; and the motors would be electric and operated by rechargeable batteries.

d. The work platform would be adjustable via a pivot point using an independent winch. The intent is to allow workers to maintain a relatively horizontal position anywhere over the structure.

e. Each worker would be independently attached with a safety cable.

f. The cart would have large soft flat rubber wheels of at least 20 inches in diameter. Such wheels can roll over glass and mullions without damaging the surface. The front wheels would be oriented to adjust the course of the cart over the glazing system.

g. The work platform would have part of its deck capable of being flipped open so as to provide an open area large enough to handle the largest piece of glass on the structure.

h. The sketches in Appendix C detail the dome structure outline as well as the cart shown at various positions along the facade.

i. The following issues are also of importance:
    I. A foolproof attachment is needed between the cables and the cart winches.
    II. Rechargeable batteries need to be sealed as they will move along with the cart's travel.
    III. The cart winches are of a special design considering the length of cable needed from the apex (estimated at 125 feet).
    IV. The cart winches are independent to provide redundancy.
    V. Safety issues must be closely looked at during the design of this unit.

j. In order to facilitate the use of the maintenance cart, or for other possible maintenance system, it may be necessary to modify the lightning conductors on the outer shell of the Dome.

LOWER LEVEL FAÇADE REVIEW

Introduction

In addition to the glass facades of the three domes showing significant sign of distress and water leakage, the lower level facades at the foundation of the Arid Dome and at the lower level Mechanical Rooms are also showing significant signs of distress. Based on visual observations, and some minor destructive testing, the lower level façade review concluded that the supports for the precast concrete panels and masonry brick cladding are failing primarily due to water infiltration and rusting of the support and connection steel. Pieces of the façade have broken away from the building. Following is a detailed description of the study findings.

Arid Dome Precast Concrete Wall Panels

The northeast quadrant of the Arid Dome has an exposed foundation wall. This wall is clad with cobble-faced precast concrete panels to match the exterior precast concrete panels used around the base of the three main domes. A review of the original construction plans and a visual inspection were performed to determine the condition of this façade. Based on these reviews, a portion of a joint between panels was removed to verify the construction, and to determine the type and condition of the panel anchors.

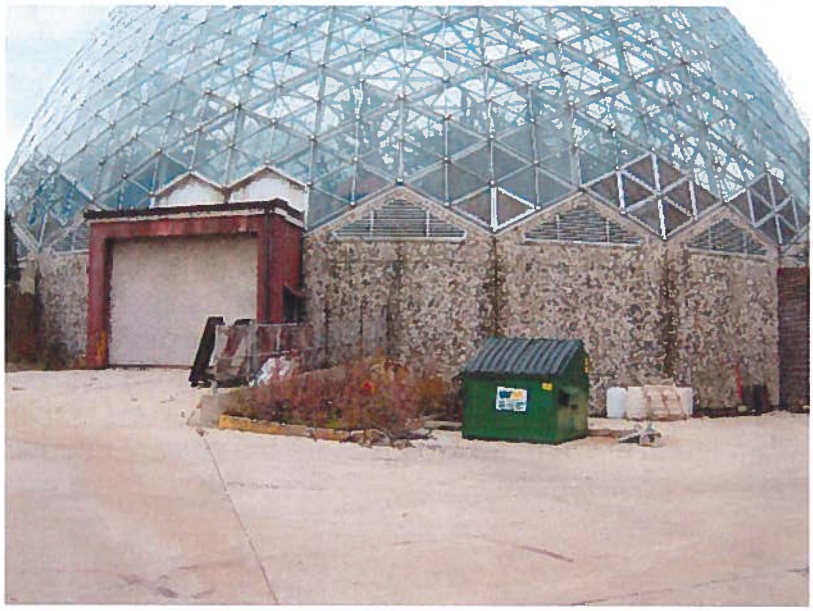


Figure 18: North Wall of Arid Dome

Lower Level Façade Study

Plan Review

The set of construction plans, dated January 15, 1959, indicates 2-inch thick, full height precast concrete wall panels with a "beach stone" finish were used to cover the exposed portion of the Arid Dome concrete foundation walls. The vertical full height panels are approximately 8'-8" wide. A 1-inch space between the concrete foundation wall and the back of the panel was to be grouted solid. The bottom of the panel was to be supported by a continuous 3 ½ x 2 ½ x ½-inch steel angle fastened to the foundation wall. No indication of the fastener size or spacing was noted. There were no details indicating the connection at the top of the panel.

Visual Inspection

The existing precast panel installation varies considerably from the building plans. The panels are installed as two stacked pieces rather than one continuous vertical piece. The thickness of the precast panels is approximately 2 ½ inches. The continuous base angle has a 4-inch horizontal leg. There are no weep holes or flashings visible at the base of the panels. Repairs have been made to reinforce or replace the bottom angle at some locations. The façade was divided into sections, comprised of two vertical panels each, to document the varying conditions and deterioration found. The wall sections, as noted below, are diagrammed on Exhibits SD-14 and SD-15 in Appendix A.

Section A1 (South of Arid Dome Entrance Vestibule)

This section has a cast-in-place concrete retaining wall abutting the left edge of the left panel. The wall is poured tight to the panel face. There is a vertical crack in the upper left panel above the retaining wall. There is a vertical crack in the lower left panel approximately 6 inches from the retaining wall. There is a spall in the upper right panel with a reinforcing bar exposed. The right edge of this section terminates approximately 3 inches from the wall of the dome entrance vestibule. The end of the space behind the panel is closed with a ¾-inch thick mortar fill over a 1-inch insulation board. The majority of this end seal was found to be cracked and loose.

The base support angle of the right panel is severely corroded. The rust expansion fills the entire ¾-inch space between the bottom of the panel and the concrete pavement slab. A pavement curb is poured tight to the face of the panel at the center joint. The base of the left panel is covered with 8 inches of soil and was not inspected. The base angle under this panel is assumed to be in the same condition as the exposed base angle. The sealant material placed over the mortar joints between panels is poor in many locations. Cracks were found in the mortar joint where the sealant material was missing.

Section A2 (North of Arid Dome Entrance Vestibule)
The left edge of the left panel terminates approximately 3 inches from the wall of the dome entrance vestibule. This end seal was found to be in good condition. The end seal is expected to be a ¾-inch thick mortar fill over a 1-inch insulation board similar to the seal in Section A1. The base angle of the left panel is severely corroded. The concrete pavement in front of the left panel is tight at the left side and approximately a half-inch below the base angle at the right edge. There is a retaining wall at the right edge of the left panel. This wall is poured tight to the panel face. The grade is lower on the right side of the wall. A small portion of the left panel and the entire right panel are taller to accommodate this grade change. The base of the right panel is covered with approximately 6 inches of soil. The condition of the right panel base angle is expected to be as severely corroded as at the visible left panel. There is a concrete curb poured tight to the face of the right panel at the right edge. The sealant covering the mortar joint between panels is poor in a few locations.

Section A3
The base angle of the left panel is tight to the concrete slab at this section. The base angle is severely corroded. There is a 2-foot long concrete spall at the base of this panel. The base angle at the right panel is severely corroded. The gap between the pavement and the base angle increases to the right. The sealant covering the mortar joints between panels is in good condition.

Figure 19: Severely Corroded Panel Support Angle

Section A4 (East of Mechanical Room Basement Wall)
The base angle under both panels in this section has been replaced. The new angle stops short of the panel ends. The new angle is a 4" x 4" x 3/8-inch angle with the vertical leg facing down. The angles are fastened to the concrete foundation wall with four ½-inch diameter drilled-in anchors. The right edge of this section terminates approximately 3 inches from the Mechanical Room basement wall. The end seal is expected to be a ¾-inch thick mortar fill over a 1-inch insulation board similar to the seal in Section A1. This end seal was found to be tight. The sealant covering the mortar joints between panels is in good condition.

Exploratory Inspection
A 30-inch long section of sealant and mortar joint was removed from a horizontal and vertical joint at the center of Section A3. The precast concrete panel was measured to be 2 ½ inches thick. The cavity behind the panel is 1 ½ inches wide and is not filled with grout. The panels have a continuous shallow groove cast into the top and bottom edges. Six inch long pieces of steel angle, with a 2 ½ inch outstanding leg, are used to tie the panels to the concrete foundation walls. A piece of 3/8-inch diameter rod is welded to the top and bottom, at the tip of the angle, to capture the groove in the precast panels. The connection angles are located 18 inches from the ends of the panels. The angle inspected had surface rust without any loss of section. It is assumed that there are three connection angles per panel. The fastening of the connection angles to the wall could not be verified. The fasteners of the base support angles cannot be verified without removal of the wall panels.

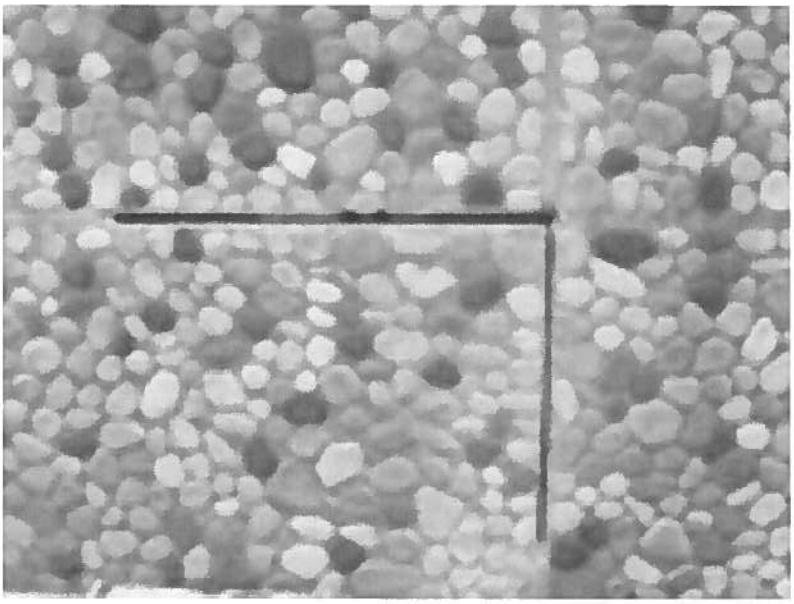


Figure 20: Exploratory Investigation at Section A3

Analysis
The condition where the concrete retaining walls have been poured tight to the rough surface of the precast concrete panels has created an interlocking bond. Thermal movement of the panels and lateral movements of the retaining wall are responsible for the cracking in these panels. Water intrusion into these cracks can eventually lead to freeze-thaw damage of the concrete or spalling from corrosion of the reinforcing steel.

Trapped moisture in the cavity behind the precast panels, from condensation and salt-laden snow on the exterior, has corroded the base angles. The rust expansion of the angles has caused the spalling at the bottom of several wall panels. The continued loss of material from the support angles can eventually lead to the panels falling off the building.

Mechanical Room & Transition Greenhouse Brick Veneer

The Mechanical Room for the Mitchell Park Domes is located in the basement between the Arid Dome on the south and the Transition Greenhouse on the north. The roof over this area creates a Plaza between the Arid Dome, the Show Dome, and the Transition Greenhouse. The basement wall on the east side is constructed of concrete with a brick veneer cladding.

The south half of the Transition House has a partial basement adjacent to the Mechanical Room. The remaining portion has an intermediate level with office and locker rooms. The exterior grade slopes up around the Transition House from the basement level at the south end, to the intermediate level on the east, and continues to the first floor level at the west. The walls have a slight inward taper from the base to the top. The remaining southwest quadrant has a 32-inch high breast wall constructed above the Plaza. A circular, steel framed, greenhouse is supported on top of the wall. The foundation wall is not circular but is comprised of 24 straight segments. The exposed portion of the basement and foundation walls are clad with a standard size brick veneer. At each of the corners, a precast stone insert is used to create the angle between the adjacent brick panels. Precast stone sills and jamb trim are used at the windows and man doors.

Figure 21: Exterior Wall at Mechanical Room

A review of the original construction plans and a visual inspection were performed to determine the condition of the façade. Based on these reviews, two locations were selected for removal of the brick for inspection openings. The openings were created to determine the conditions of the façade, foundation wall, and façade anchors at these locations.

Plan Review

The set of construction plans, dated January 15, 1959, indicate the concrete foundation walls have a 1:24 taper. A 1 3/8-inch space between the brick and the concrete wall is indicated to be grouted solid. The brick on the Mechanical Room walls and the Transition House walls, outside of the basement area, were to be supported on 6 x 4 x 3/8-inch angles. The sections and details do not indicate the fastener size or spacing for these angles. The remaining portion of the Transition House shows the brick veneer supported on a 24-inch deep concrete ledge that was added to the previously constructed foundation wall. The brick was to be tied to the concrete wall with corrugated metal ties fastened with masonry nails.

Figure 22: Exterior Wall at Transition Greenhouse

The precast stone sills were set on the masonry with a copper flashing below. The precast stone jamb trim and corner trim are shown to be set in mortar without any ties. The overhead door into the Transition House basement is framed with bent steel plate jambs and a steel plate head.

The flashing over the masonry, at the top of the wall, is an aluminum sheet sealed to the greenhouse framing, with a 1-inch return lip over the brick. A splice piece is located at each of the corners. The flashing over the heads of doors and windows is copper sheeting.

It was noted by Milwaukee County staff that a section of the brick veneer was recently replaced on the Mechanical Room. No plans, specifications or reconstruction details were available for review.

Visual Inspection

The façade appears to have been built as indicated on the plans and sections. Significant deterioration of the precast stone elements was noted. The inspection surface was divided into sections, generally between doors or corners, to note the varying conditions and the deterioration found. The wall sections, as noted below, are diagrammed on Exhibits SD-14 and SD-15 in Appendix A.

Sections B1 and B2 (Mechanical Room Basement Wall)
The brick is supported on a steel angle. The original angle has been replaced with a 4 x 4 x ¼-inch angle with ½ -inch diameter anchors at approximately 24 inches on center. The variation in mortar joint color and texture indicates the lower 11 feet of the brick veneer on Section B1 and the lower 9 feet on Section B2 have been rebuilt. There are no weep holes in Section B1. Section B2 has rope-filled weeps at 24-inch spacing. The original precast stone door trim has been removed at the man door. The cavity between the brick and the concrete foundation wall is filled with grout. Wall movement adjacent to the door frame indicates that this wall has pushed out approximately 3/16 inch. The masonry is built tight to the underside of the concrete plaza slab over the Mechanical Room.

Section B3 (Vestibule Basement Wall between Mechanical Room and Transition House)
The original base support angle on this section of wall has been reinforced with 8-inch sections of 4" x 4" angles at approximately 20 inches on center. The brick is in good condition. The precast stone jamb at the right side of the Mechanical Room entrance man door has a spall at the bottom with the reinforcing bars exposed. The remaining jambs have random hairline cracks.

Section B4 (Transition House Basement Wall between Vestibule and Overhead Door)
The support angle at the base of the brick veneer has been replaced with a 4 x 4 x ¼-inch angle with ½-inch diameter anchors at approximately 32 inches on center. The upper sections of the precast corner trim on the left side of this section are missing. (See Figure 23). A 3/8 to ½-inch gap is visible at this location between the original grout fill and the concrete wall. A 3 x 4 x ¼-inch intermediate shelf angle is visible on both sides of this exposed corner. The joint in front of the outstanding leg is filled with mortar. There is no flashing at this intermediate support. The anchors for these members are not visible. The upper sections of the precast window trim are cracked with small spalls.

Figure 23: Missing Precast Concrete Corner Trim

Section B5 (Transition House Basement above Overhead Door)
The overhead door is framed with steel plates. They generally have light surface rust. The base of the right jamb has corroded through the entire thickness indicating severe corrosion on the backside. The face of the corner trim on the right side has spalled off to the depth of the reinforcing.

Sections B6 and B7 (Transition House Basement Wall)
The base angles at these sections have been reinforced with 8-inch sections of 4 x 4 steel angles at approximately 20 inches on center. The outstanding leg of the original support angle has various degrees of corrosion. Several have severe corrosion causing rust jacking. The precast window jambs have severe cracks on the lower sections. The joints between the window trim and brick are cracked. The gaps and mortar joint movement at the window jambs and sills indicate the brick has moved ¼ to ½ inches away from the backup concrete wall. The precast corner trim between these sections is missing. A gap behind the mortar fill is visible. No additional shelf angles are visible.

Section B8 (Transition House Basement Wall)
The base angles at this section have been reinforced with 8-inch sections of 4 x 4 steel angles at approximately 20 inches on center. The outstanding leg of the original support angle has severe corrosion causing rust jacking. Weep holes are visible in the mortar joint above the angle. These weeps are plugged with mortar approximately 3/4 inches in. The precast concrete door jambs have severe cracks. A section of the right jamb has fallen off. A gap between the precast trim and the door frame indicates the

brick has moved ¼ inch away from the backup concrete wall. The mortar joint between the precast corner trim and the brick is cracked on each side of this section.

Sections B9 and B10 (Transition House Basement Wall)
These sections are supported on a concrete ledge. Weep holes, 3/8 inches in diameter, are provided at 24 inches on center. These weeps are plugged with mortar approximately 3/4 inches in. The window precast concrete jambs on Section B9 have hairline cracks and the mortar joint to the brick facing is cracked. The jambs at Section B10 are severely cracked and spalled. (See Figure 24). There is a horizontal crack in the mortar joint left of the window head at Section B10. The precast corner trim between these sections has several hairline cracks.

Figure 24: Failed Precast Concrete Door Trim

Section B11 (Transition House Basement Wall)
Section B11 has a 22 x 24-inch air vent. This vent has masonry returns at the jambs and a sloped brick sill. The gaps around the vent indicate a ¼-inch lateral movement of the brick facing. A 1/16-inch horizontal crack runs the entire length of this panel at the head of the vent.

Sections B12 through B17 (Transition House Basement Wall)
These sections do not have any wall penetrations to indicate wall movement. A horizontal crack runs the entire width of the panel slightly below mid-height.

Section B18 (Plaza Area Breast Walls)
The brick façade on the southwest quadrant breast walls appear to have been built on a concrete ledge. The precast corners between panels are cracked or spalled. The gaps in the top flashing indicate the brick facing has moved up to a 1/2 inch away from the concrete backup wall. (See Figure 25).

Figure 25: Top of Wall Flashing at Breast Wall

Invasive Inspection

Two locations were selected to determine the condition of the façade at areas with minor cracks. Mid-height removal of the brick façade was performed in Section B9 and Section B13. Approximately 10 bricks were removed at each location. These inspections confirmed that the cavity behind the brick had been grouted solid and that separation from the concrete foundation wall has occurred. Section B9 has separated approximately 1/8 inch and Section B13 has separated approximately ½ inch. The concrete foundation wall was found to be in good condition at both locations. The corrugated ties found at the opening Section B9 are corroded. No ties were visible at the opening at Section B13.

Analysis

The brick veneer on the basement walls has pulled away from the concrete foundation walls to varying degrees around the Mechanical Room and the Transition House. It is assumed that temperature variations between the brick veneer and the concrete foundation wall originally created a gap at this plane. Moisture penetrating the brick veneer system condenses on the colder side of the gap. In addition, condensation on

the inner glass dome surfaces of the Transition House could be penetrating the inner flashing and entering the cavity. The lack of operable weep holes at the base of the walls prevents this water from escaping. Subsequent freezing of this moisture has "pryed" open the gap. The wall movement has created sealant failure and gaps in the flashing at the top of the wall. These openings allow greater volumes of water to enter, further widening the gap. This movement, along with corrosion of the wall ties, has increased until the anchors no longer tie the wall to the back-up.

The steel angles at the base of Sections B1 through B8 are exposed to rain-driven water and salt-laden snow during the winter. In addition, these angles are exposed to the moisture held in the gap between the grout fill and the concrete foundation wall backup. The corrosion of these elements will continue and will require future replacement.

The precast concrete jambs and corner elements were poorly connected to the structure. The porous nature of this material allows moisture to penetrate the surface. The subsequent corrosion of the reinforcing steel causes the cracks and eventual spalling. Since no expansion or control joints were provided, thermal forces have pushed the corner elements away from the concrete wall and cracked the mortar joints at the window trim elements.

LOWER LEVEL FAÇADE RENOVATION OPTIONS

Arid Dome Precast Concrete Wall Panels

Several options for the stabilization or renovation of the precast concrete façade elements at the Arid Dome foundation wall are recommended as follows:

Option A1 – Precast Concrete Panel Facade Repairs
The following repairs are recommended to stabilize and improve the function of the precast concrete wall panels in this area. This type of stabilization and repair would be expected to last from 5 to 8 years.

1) The end of the retaining walls should be cut to provide a break between the retaining walls and the precast concrete wall panels. A soft filler and sealant joint should be provided to retain the soil behind the wall.

2) The panel cracks should be routed and sealed to prevent water intrusion.

3) The deteriorated base angles should be replaced with galvanized steel angles. Removal of the pavement below and in front of the panels will be required to install the new angles. Reconfiguration of the pavement will be required to provide a drainage space below the base angles.

4) Additional weep holes should be provided in the panels.

5) The concrete curbs should be cut back from the face of the wall panels and the soil should be removed from in front of the wall panels. The curb can be returned to the concrete retaining wall to terminate the planting area. A drainage trough at least 2 inches below the base angle should be created in front of the panels at the planters.

Conceptual Estimate of Project Costs for Option A1

Façade Repairs	$ 26,000
Contingency – 20%	$ 5,000
Design Fees – 10%	$ 3,000
County Admin. Costs – 10%	$ 3,000
Total =	**$ 37,000**

Option A2 – Precast Concrete Panel Full Façade Reconstruction
Long term improvements to the existing façades would require complete removal and replacement of the wall panels. New galvanized steel support angles would be installed at the base with new flashings and weep holes. Galvanized or stainless steel anchors would be provided at the intermediate connections.

This type of reconstruction would be expected to last from 30 to 40 years.

Conceptual Estimate of Project Costs for Option A2

Façade Reconstruction	$ 107,000
Contingency – 20%	$ 21,000
Design Fees – 10%	$ 11,000
County Admin. Costs – 10%	$ 11,000
Total =	**$ 150,000**

Option A3 – Precast Concrete Panel Removal
The precast concrete panels could be permanently removed leaving the exterior face of the foundation wall exposed. The concrete surface would require minor repairs where the existing anchors and panel ties were removed. A waterproof sealer or protective coating would be applied to the exposed concrete surfaces.

Conceptual Estimated of Project Costs for Option A3

Façade Removal	$ 77,000
Contingency – 20%	$ 15,000
Design Fees – 10%	$ 8,000
County Admin. Costs – 10%	$ 8,000
Total =	**$ 108,000**

Mechanical Room & Transition Greenhouse Brick Veneer

Important Note:

To protect the occupants and suppliers using this portion of the building, it is recommended that all loose pieces around the man doors and overhead doors be identified and removed as soon as possible.

Several options for the stabilization or renovation of the brick façade elements at the Mechanical and Transition Greenhouse walls are recommended as follows:

Option B1 – Masonry Façade Stabilization and Repair

The façade could be stabilized by providing helical renovation anchors through the façade to assure the attachment of the veneer to the backup. Additional investigation could be performed to limit the reattachment to areas where the wall has separated by more than 1/8 inch. The flashing at the top of the wall should be resealed or replaced as necessary to prevent water entry into the wall. The interior Transition House dome window base should be sealed. At the Mechanical Room, the mortar joint at the top of the wall should be removed and replaced with a sealant joint to allow vertical expansion of the facade. The existing weep holes should be drilled out or new weeps added to allow moisture to escape from the cavity. The precast trim pieces could be removed and replaced with bent metal flashings.

This type of stabilization and repair would be expected to last from 5 to 8 years.

Conceptual Estimate of Project Costs for Option B1

Façade Repair	$ 48,000
Contingency – 20%	$ 10,000
Design Fees – 10%	$ 5,000
County Admin. Costs – 10%	$ 5,000
Total =	**$ 68,000**

Option B2 – Masonry Façade Full Reconstruction

Long term repair and improvements to the system would require complete removal of the brick façade and precast concrete trim pieces. The base angles should be replaced with galvanized steel angles with stainless steel anchors. These angles would have a longer life than the current bare steel angles. To further increase the life of the base support, the angles could be replaced with a concrete curb.

The new brick façade should be installed with a cavity space between the brick and the concrete wall. Base flashing and weep holes should be provided. New galvanized brick ties should be installed at the appropriate spacing. Expansion joints should be added on each side of the corner trim. The corner trim pieces could be replaced with new units to match the existing to maintain the historic look of the façade. The new units should be fastened to the concrete foundation wall. Alternatively, the brick could be cut to fill this corner space.

The window trim should be replaced with new precast concrete units that are attached to the concrete foundation wall. Alternatively, these could be eliminated and replaced with bent metal flashing or with brick returns. The exterior flashing at the top of the wall should be reset and resealed. The interior dome window base should be sealed.

This type of reconstruction would be expected to last from 30 to 40 years.

Conceptual Estimate of Project Costs for Option B2

Façade Reconstruction	$ 215,000
Contingency – 20%	$ 43,000
Design Fees – 10%	$ 21,000
County Admin. Costs – 10%	$ 21,000
Total =	**$ 300,000**

Option B3 – Masonry Façade Removal

The brick façade could be permanently removed leaving the exterior face of the foundation wall exposed. The concrete surface would require minor repairs where the existing anchors and brick ties were removed. A waterproof sealer or protective coating would be applied to the exposed concrete surfaces.

The sills at the windows would require replacement or modification with new sill flashing. The jambs may require sheet metal flashing. Additional destructive examinations would be required to determine this detail. The metal panel over the Mechanical Room overhead door would require replacement for this façade removal option.

The windows could also be eliminated and filled with a concrete or glass block. The vents in the upper window panel would have to be replaced and the ventilation ductwork modified.

Conceptual Estimate of Project Costs for Option B3

Façade Removal	$ 118,000
Contingency – 20%	$ 24,000
Design Fees – 10%	$ 12,000
County Admin. Costs – 10%	$ 12,000
Total =	**$ 166,000**

Option B4 – Masonry Façade Combined Option

A combined and phased approach to maintaining and repairing this façade is also an option. Sections B1 and B2 have been recently repaired and could be monitored for further deterioration. Section B3 is in good shape and would only require the removal of the precast concrete door jambs. Any gaps between the wall and brick façade could be sealed. The brick veneer at Section B4 would be replaced, with sheet metal trim provided at the jambs and corners. Sections B6 and B7 would be stabilized and monitored. The remaining sections would have the window and door jambs replaced with bent sheet metal and the brick veneer would need to be monitored for further deterioration. All sections not replaced would have new weep holes installed in an attempt to provide a passage for any water collection in the void space. All sections would have the flashing at the top of the wall reset and resealed.

Conceptual Estimate of Project Costs for Option B4

Façade Repair & Reconstruction	$ 70,000
Contingency – 20%	$ 14,000
Design Fees – 10%	$ 7,000
County Admin. Costs – 10%	$ 7,000
Total =	**$ 98,000**

STUDY SUMMARY

Show Dome Facade
Based on visual observations, the Show Dome review concluded that the facade has broken and leaking glass, faulty aluminum framing components, and a poorly functioning condensate drainage system. All of these issues have created extensive water dripping within the Show Dome. The concrete frame was found to be in fair condition, however, the paint is fading and peeling, and isolated areas of concrete cracking and deterioration are present. At one observed location, the connection between the aluminum façade frame and the concrete frame has completely failed, and this condition needs to be repaired immediately to ensure that the structural integrity of the dome system is not compromised. Delayed maintenance of any of these systems will result in accelerated deterioration and continued failure of the dome components.

Show Dome renovation options include the following:

- Option 1 includes replacing damaged glass, repairing aluminum framing components, repairing the concrete frame, and recoating the concrete frame.
  - preliminary estimated cost = $4,000,000 to $6,000,000.

- Option 2 includes replacing all glass with double pane insulated glass, repairing aluminum framing components, repairing the concrete frame, and recoating the concrete frame.
  - preliminary estimated cost = $15,000,000 to $18,000,000.

- Option 3 includes replacing all glass and all aluminum framing with a new concrete frame supported façade system, repairing the concrete frame, and recoating the concrete frame.
  - preliminary estimated cost = $8,000,000 to $10,000,000.

- Option 4 includes replacing all glass and all aluminum framing with a new self supported façade system, repairing the concrete frame, and recoating the concrete frame.
  - preliminary estimated cost = $10,000,000 to $13,000,000.

- Option 5 includes replacing all glass, all aluminum framing, and all concrete framing with a new self supporting dome system.
  - preliminary estimated cost = $8,500,000 to $10,500,000.

Show Dome Façade & Lower Level Façade Study

Options 1, 2, 3, and 4 generally maintain the existing appearance and shape of the Show Dome, and would maintain the existing concrete frame. Option 5 would be a different shape and appearance, and would eliminate the concrete frame. Options 2, 3, 4, and 5 would all have insulated glazing which would significantly reduce the facility's energy usage. Options 3, 4 and 5 would have a new aluminum façade framing system, thus eliminating the shortfalls of the existing system.

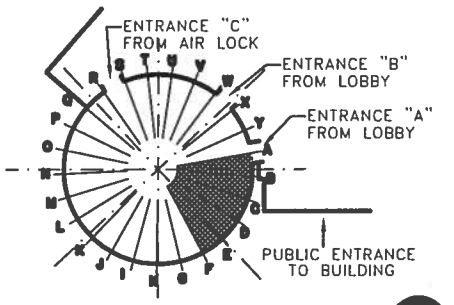
Lower Level Facade

Based on visual observations, and some minor destructive testing, the lower level façade review concluded that the supports for the precast concrete panel and masonry brick cladding are failing, primarily due to rusting of the support and connection steel. Pieces of the façade have broken away from the building. Lack of repairs will result in continued corrosion, and pieces of the façade will continue to break away from the building, potentially causing a significant hazard to Staff and visitors.

Lower level façade renovation options range from short-term minor repairs to long-term total reconstruction. The preliminary probable costs of the renovation options presented range from $100,000 for short-term minor repairs to $450,000 for long-term total reconstruction.

APPENDIX A -
Exhibits SD-1 through SD-14

SD-1	Glass Panel Evaluation – Show Dome Segments A-F
SD-2	Glass Panel Evaluation – Show Dome Segments F-K
SD-3	Glass Panel Evaluation – Show Dome Segments K-P
SD-4	Glass Panel Evaluation – Show Dome Segments P-U
SD-5	Glass Panel Evaluation – Show Dome Segments U-A
SD-6	Glass Panel Evaluation – Show Dome Apex
SD-7	Concrete Frame Evaluation – Show Dome Segments A-F
SD-8	Concrete Frame Evaluation – Show Dome Segments F-K
SD-9	Concrete Frame Evaluation – Show Dome Segments K-P
SD-10	Concrete Frame Evaluation – Show Dome Segments P-U
SD-11	Concrete Frame Evaluation – Show Dome Segments U-A
SD-12	Drainage System Evaluation – Show Dome Typical Hub
SD-13	Drainage System Evaluation – Show Dome Base Flashing
SD-14	Masonry/Concrete Façade Evaluation – Partial Plan
SD-15	Partial North Elevations – Arid Dome & Transition Greenhouse

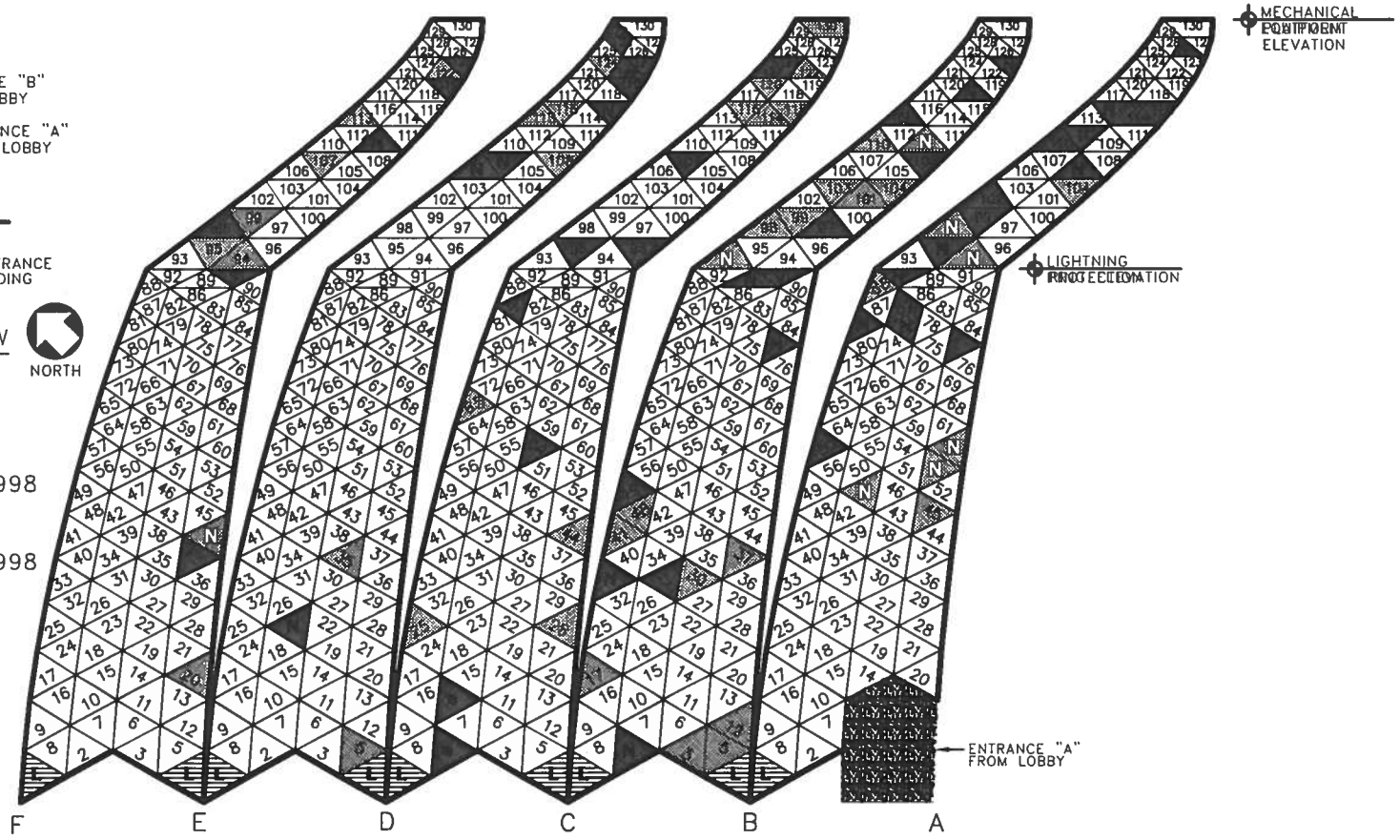


KEY – SHOW DOME PLAN VIEW

NORTH

KEY

- CRACKED GLASS OBSERVED IN 1996–1998
- PROJECTILE DAMAGED GLASS OBSERVED IN 1996–1998
- GLASS REPLACED IN 1996–1998
- GLASS REPLACED IN 1996–1998 AND RECRACKED IN 2006
- NEW CRACKED GLASS OBSERVED IN 2006
- NEW PROJECTILE DAMAGED GLASS OBSERVED IN 2006
- LOUVER
- ALTERNATE GLAZING TYPE (A)



GLASS PANEL EVALUATION – SHOW DOME SEGMENTS A–F

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

GRAEF ANHALT SCHLOEMER and Associates Inc.
One Honey Creek Corporate Center
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MITCHELL PARK CONSERVATORY
SHOW DOME FACADE EVALUATION
DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS
MILWAUKEE COUNTY

EXHIBIT SD 1

$DATES
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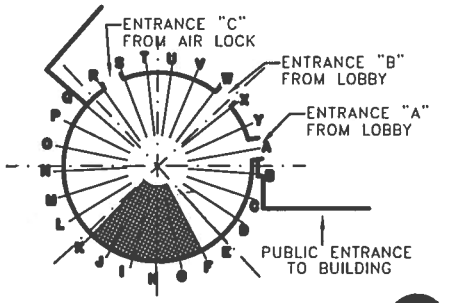


KEY – SHOW DOME PLAN VIEW

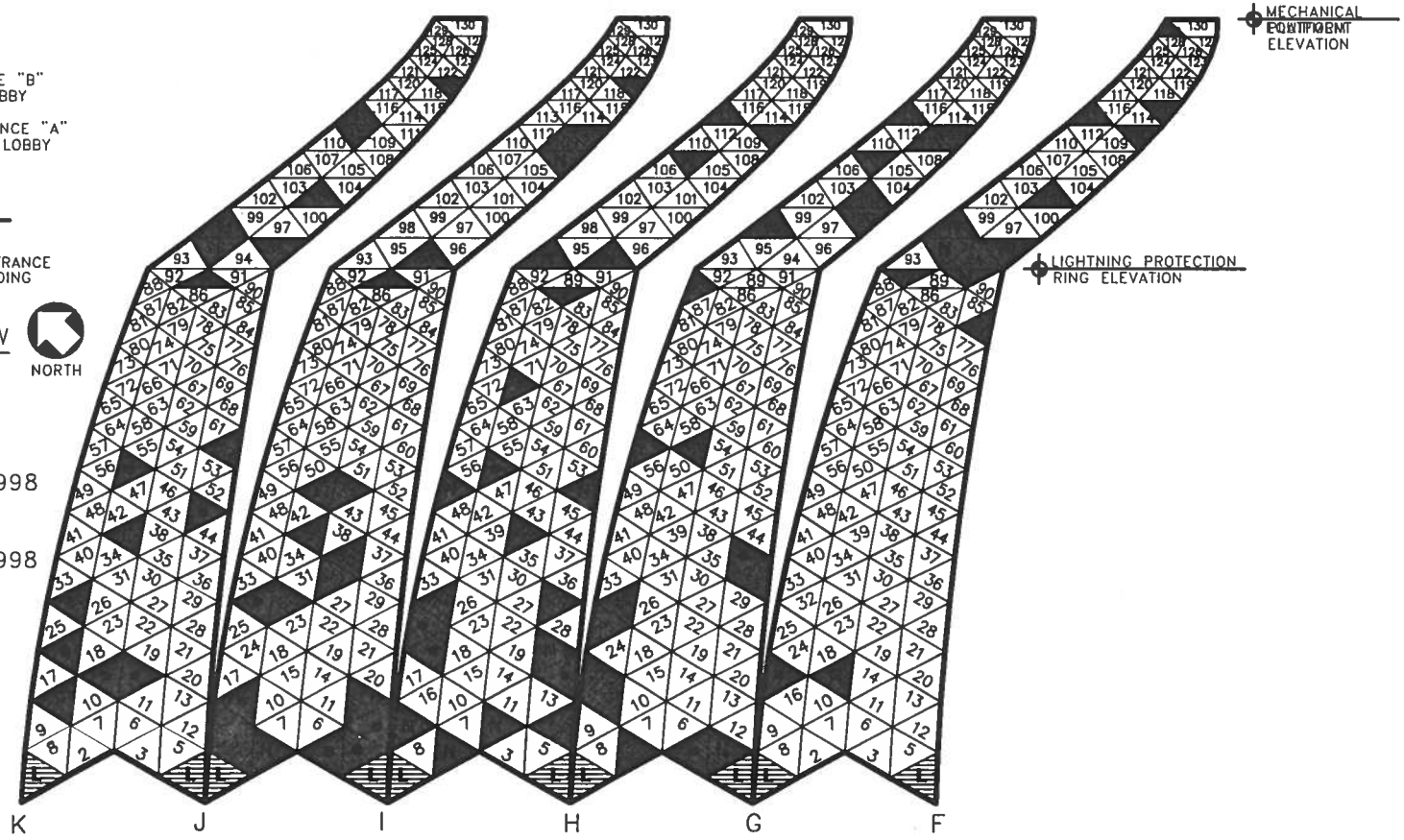
NORTH

KEY

- CRACKED GLASS OBSERVED IN 1996–1998
- PROJECTILE DAMAGED GLASS OBSERVED IN 1996–1998
- GLASS REPLACED IN 1996–1998
- GLASS REPLACED IN 1996–1998 AND RECRACKED IN 2006 (N)
- NEW CRACKED GLASS OBSERVED IN 2006
- NEW PROJECTILE DAMAGED GLASS OBSERVED IN 2006

LOUVER

ALTERNATE GLAZING TYPE (A)



GLASS PANEL EVALUATION – SHOW DOME SEGMENTS F–K

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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SHOW DOME FACADE EVALUATION

DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS
MILWAUKEE COUNTY

EXHIBIT SD 2

SDATES
STIMES
STILES

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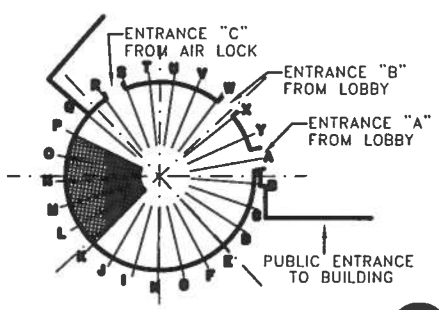

KEY – SHOW DOME PLAN VIEW

KEY

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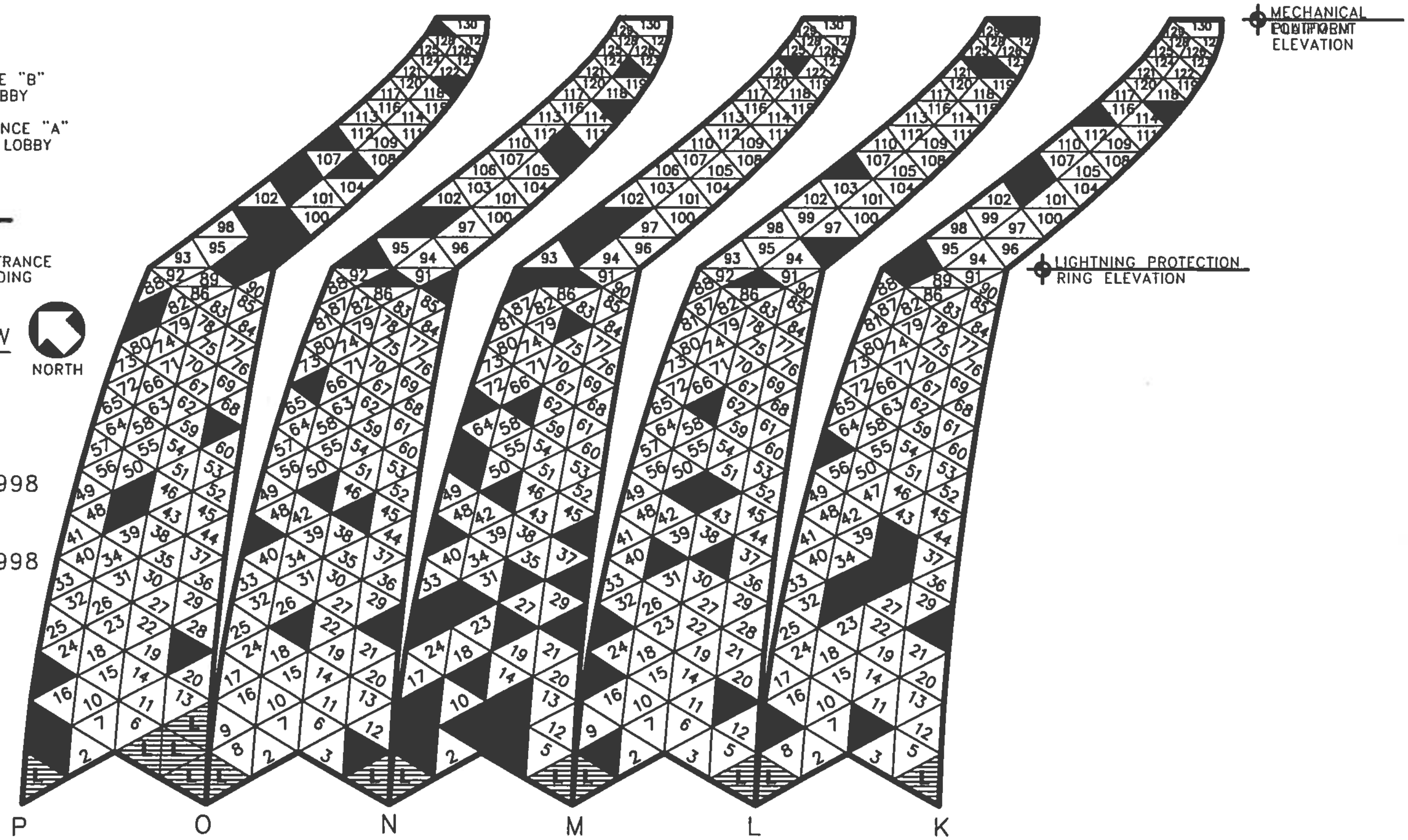
- PROJECTILE DAMAGED GLASS OBSERVED IN 1996–1998
- GLASS REPLACED IN 1996–1998
- GLASS REPLACED IN 1996–1998 AND RECRACKED IN 2006
- NEW CRACKED GLASS OBSERVED IN 2006
- NEW PROJECTILE DAMAGED GLASS OBSERVED IN 2006
- LOUVER
- ALTERNATE GLAZING TYPE



GLASS PANEL EVALUATION – SHOW DOME SEGMENTS K–P

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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MITCHELL PARK CONSERVATORY
SHOW DOME FACADE EVALUATION
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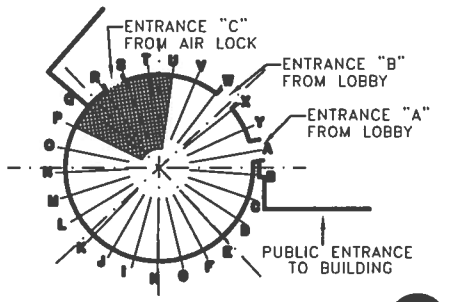
MILWAUKEE COUNTY

EXHIBIT SD 3

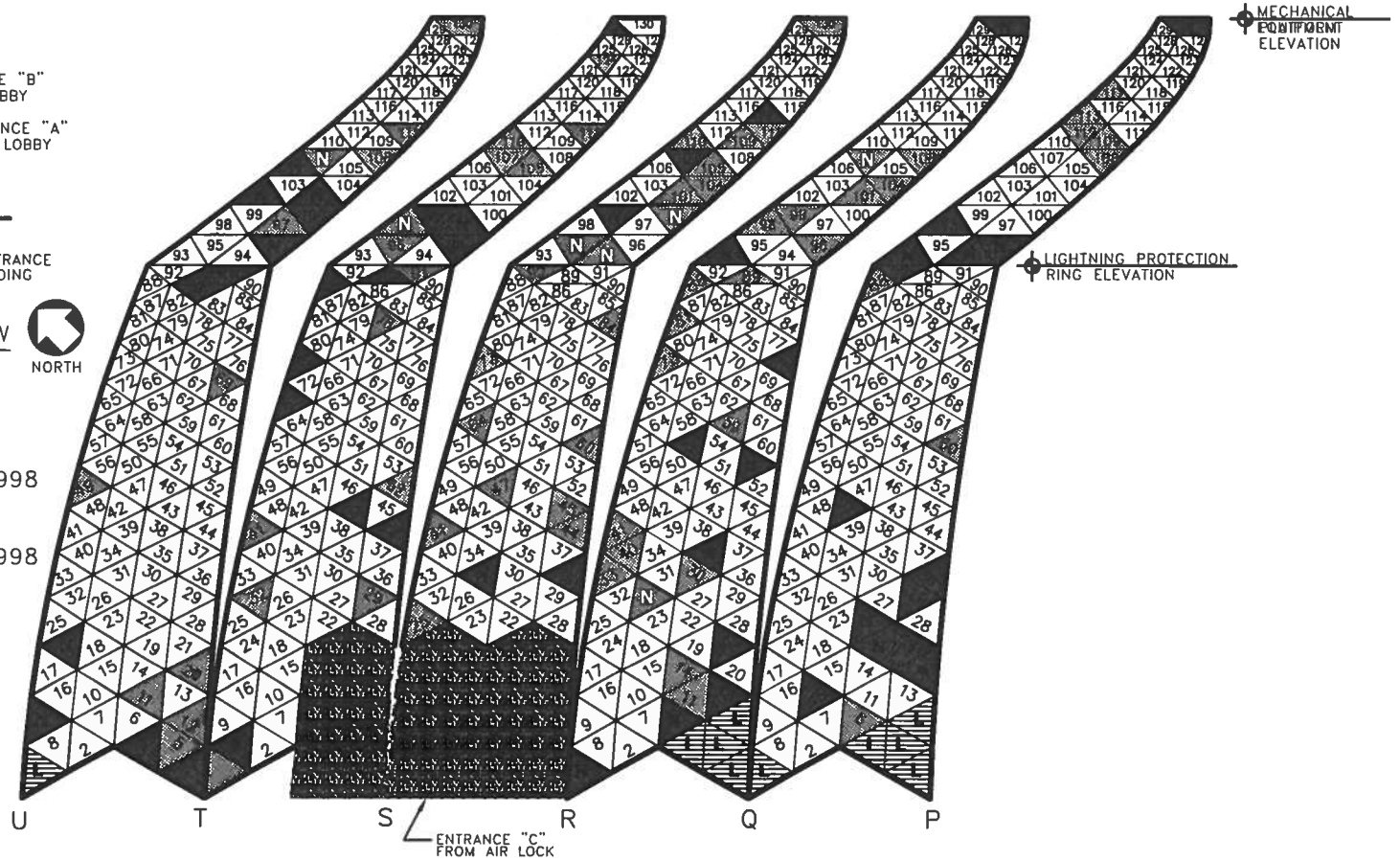


KEY – SHOW DOME PLAN VIEW

NORTH

KEY

- CRACKED GLASS OBSERVED IN 1996–1998
- PROJECTILE DAMAGED GLASS OBSERVED IN 1996–1998
- GLASS REPLACED IN 1996–1998
- N — GLASS REPLACED IN 1996–1998 AND RECRACKED IN 2006
- NEW CRACKED GLASS OBSERVED IN 2006
- NEW PROJECTILE DAMAGED GLASS OBSERVED IN 2006
- LOUVER
- ALTERNATE GLAZING TYPE
- A



GLASS PANEL EVALUATION – SHOW DOME SEGMENTS P–U

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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MILWAUKEE COUNTY

EXHIBIT SD 4

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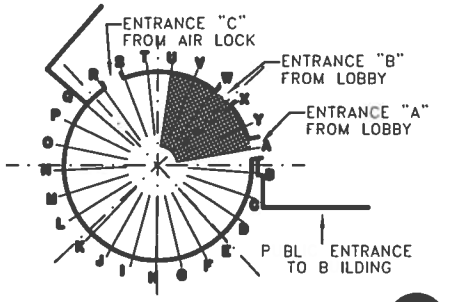
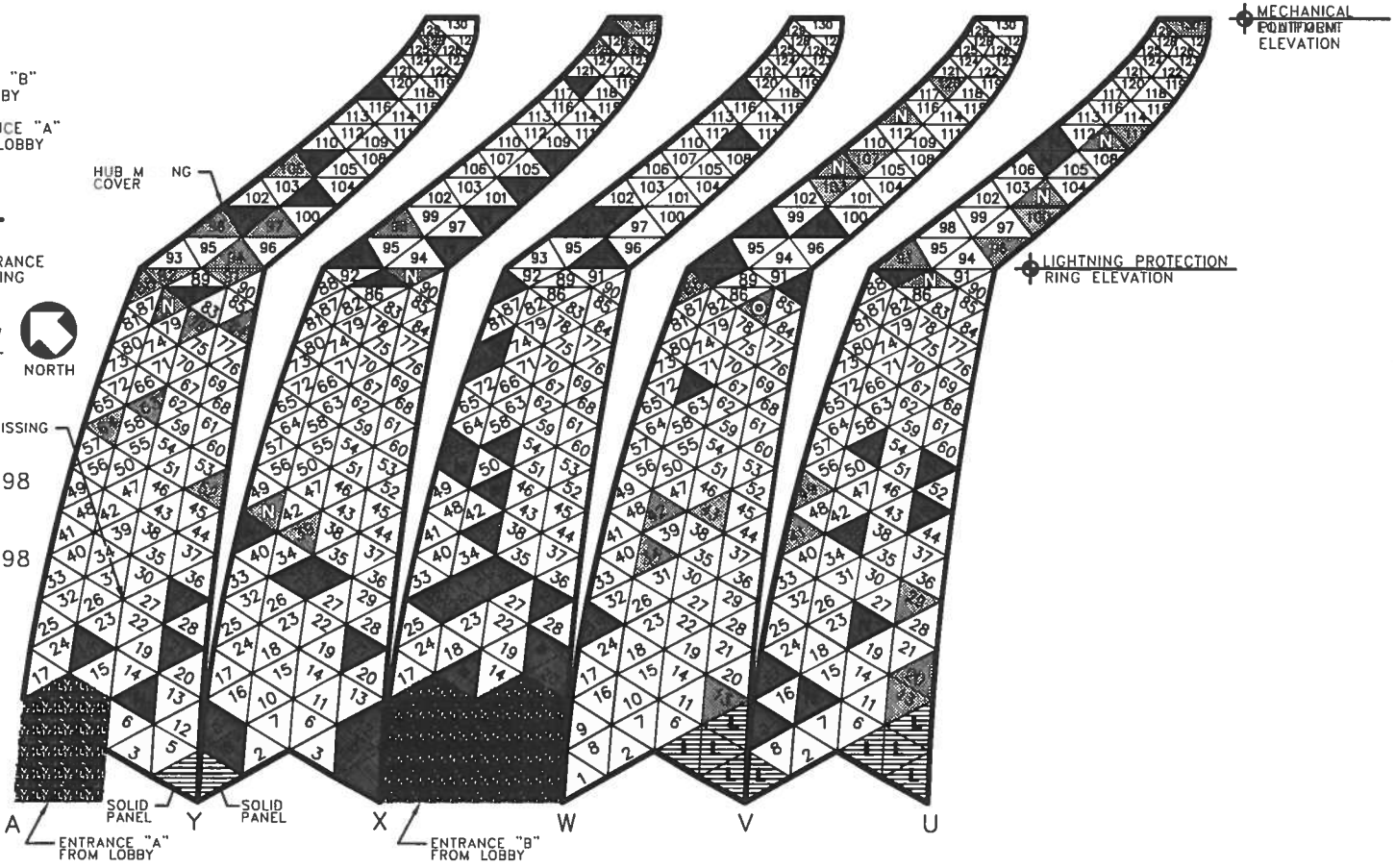


KEY – SHOW DOME PLAN VIEW

NORTH

KEY

- CRACKED GLASS OBSERVED IN 1996–1998
- PROJECTILE DAMAGED GLASS OBSERVED IN 1996–1998
- GLASS REPLACED IN 1996–1998
- N — GLASS REPLACED IN 1996–1998 AND RECRACKED IN 2006
- NEW CRACKED GLASS OBSERVED IN 2006
- O — GLASS REPLACED IN 1996–1998 AND NEW PROJECTILE DAMAGED IN 2006
- NEW PROJECTILE DAMAGED GLASS OBSERVED IN 2006
- LOUVER
- L — ALTERNATE GLAZING TYPE
- A



GLASS PANEL EVALUATION – SHOW DOME SEGMENTS U–A

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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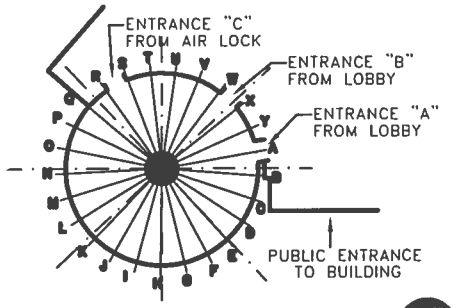
EXHIBIT SD 5

SDATES
STIMES
SFILES



KEY – SHOW DOME PLAN VIEW

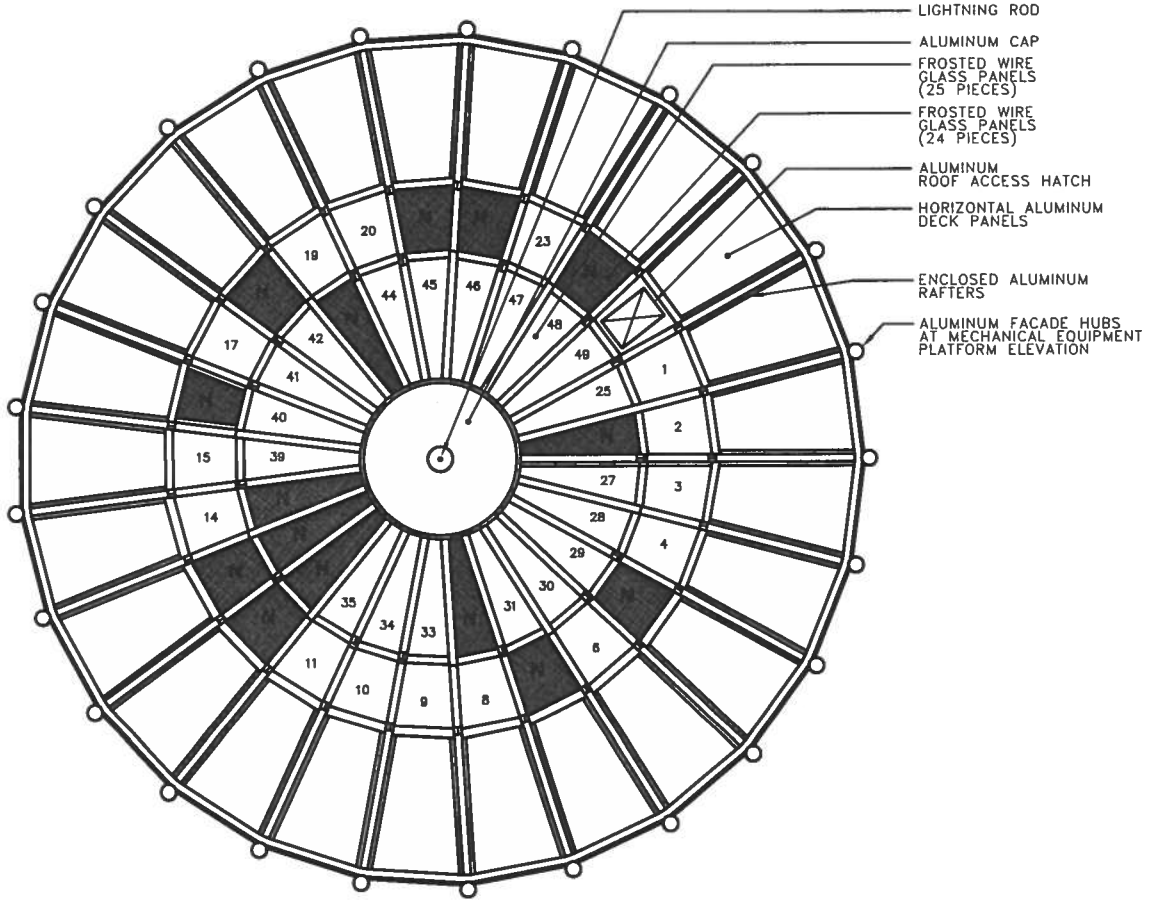
NORTH

KEY

- CRACKED GLASS OBSERVED IN 1996–1998
- PROJECTILE DAMAGED GLASS OBSERVED IN 1996–1998
- GLASS REPLACED IN 1996–1998
- N — GLASS REPLACED IN 1996–1998 AND RECRACKED IN 2006
- NEW CRACKED GLASS OBSERVED IN 2006
- NEW PROJECTILE DAMAGED GLASS OBSERVED IN 2006

LOUVER

- 1 — ALTERNATE GLAZING TYPE
- A



GLASS PANEL EVALUATION – SHOW DOME APEX – PLAN VIEW

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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MITCHELL PARK CONSERVATORY
SHOW DOME FACADE EVALUATION

DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS
MILWAUKEE COUNTY

EXHIBIT SD 6

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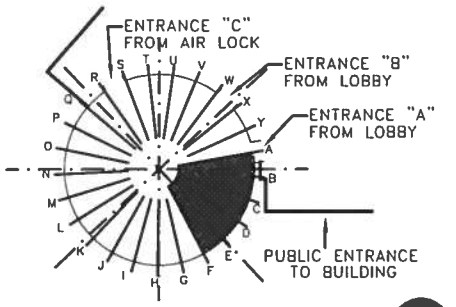
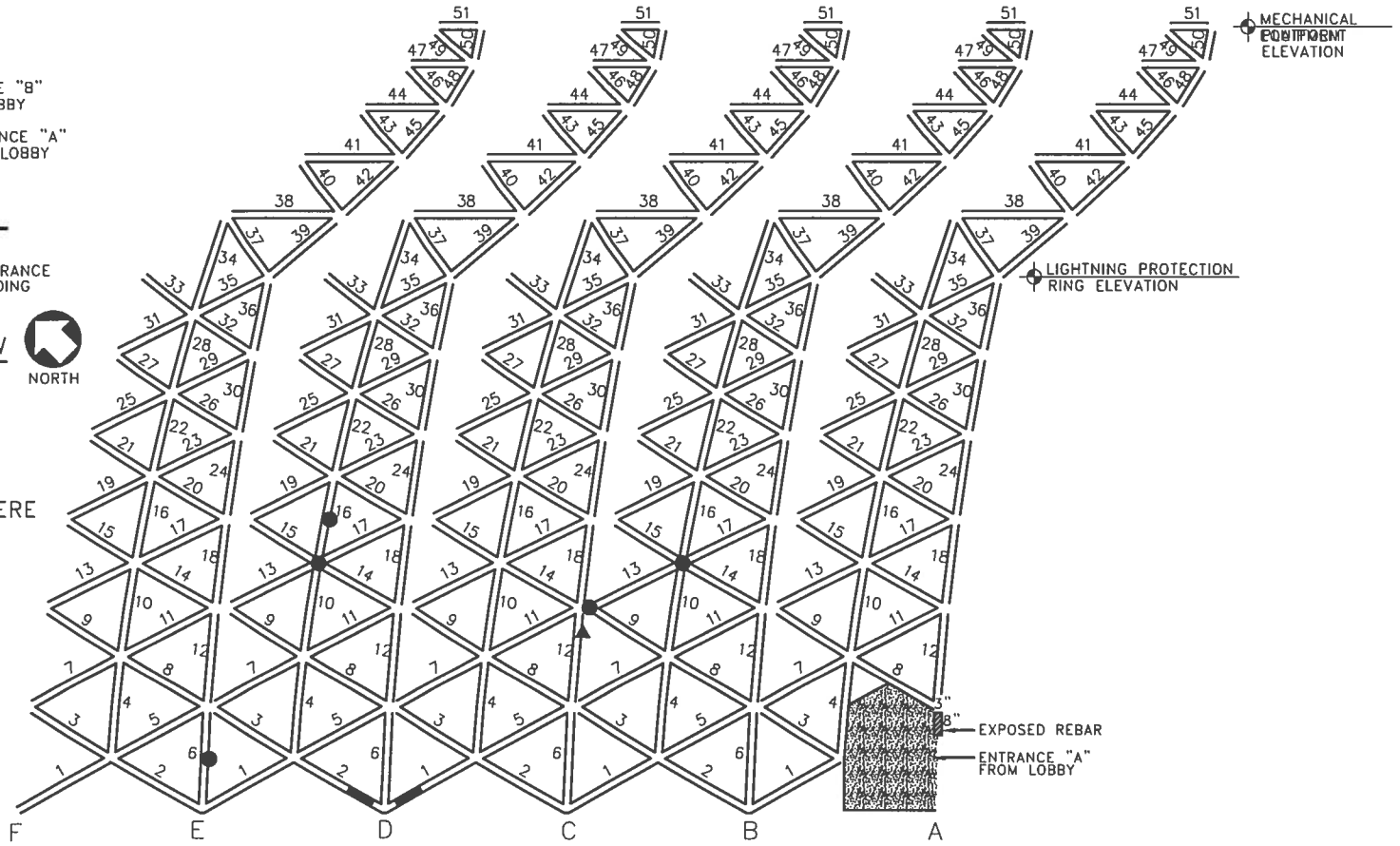


KEY – SHOW DOME PLAN VIEW

KEY

- SPALL AT HUB
- SPALL/CRACK ELSEWHERE
- MOLD/MOSSY GROWTH (MINOR)



CONCRETE FRAME EVALUATION – SHOW DOME SEGMENTS A–F

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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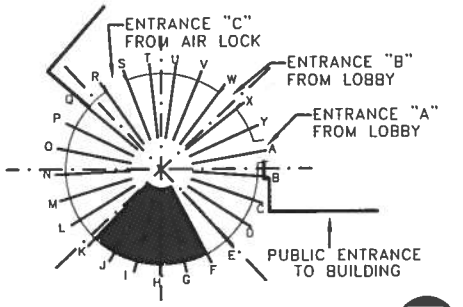
MILWAUKEE COUNTY

EXHIBIT SD 7

SDATES
STIMES
SFILES

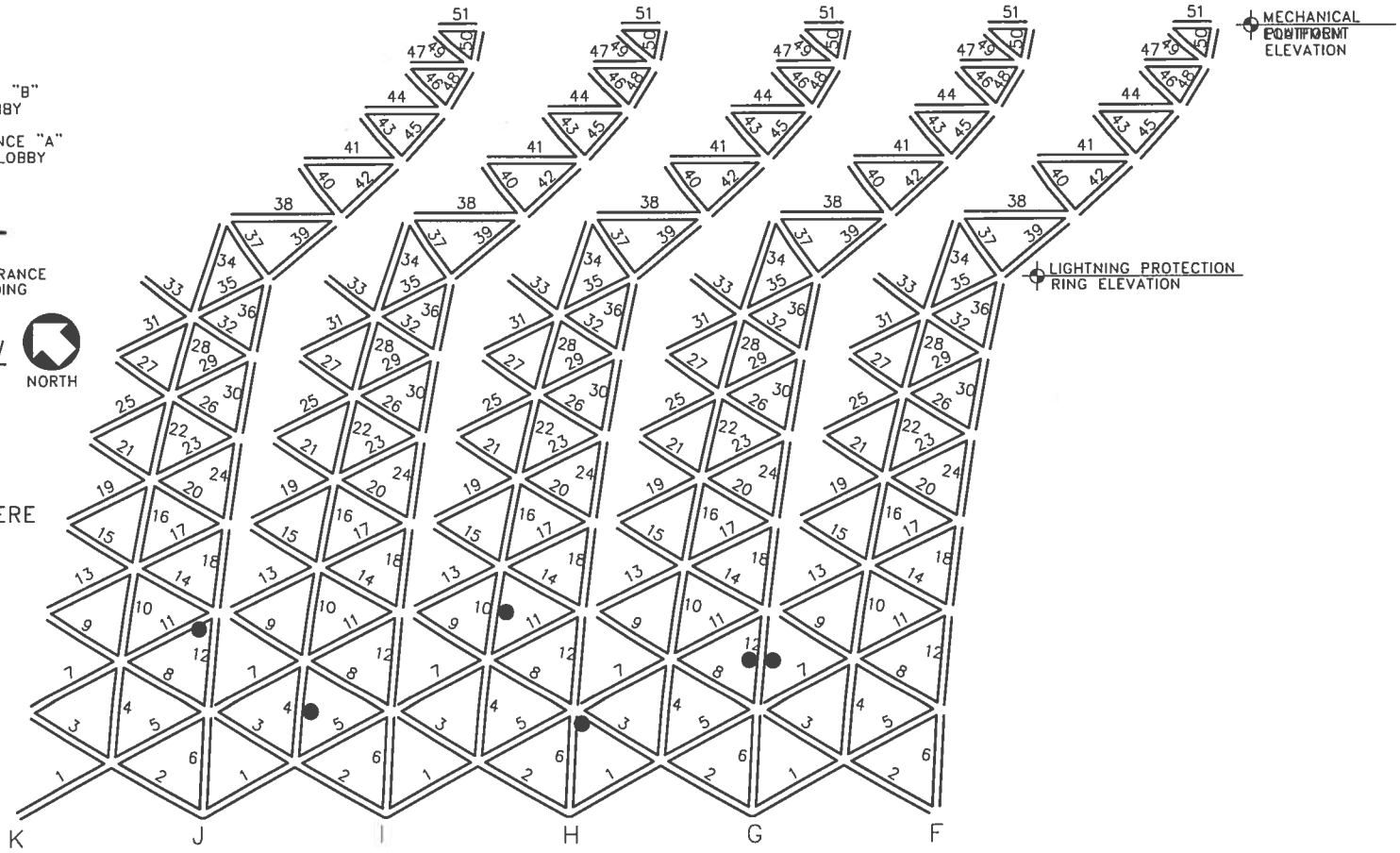


KEY – SHOW DOME PLAN VIEW

NORTH

KEY

- SPALL AT HUB
- SPALL/CRACK ELSEWHERE
- MOLD/MOSSY GROWTH (MINOR)



CONCRETE FRAME EVALUATION – SHOW DOME SEGMENTS F–K

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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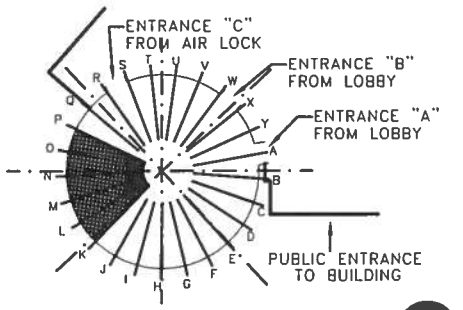
MITCHELL PARK CONSERVATORY
SHOW DOME FACADE EVALUATION

DEPARTMENT OF TRANSPORTATION
AND PUBLIC WORKS
MILWAUKEE COUNTY

EXHIBIT SD 8

$DATE$
$TIME$
$FILE$

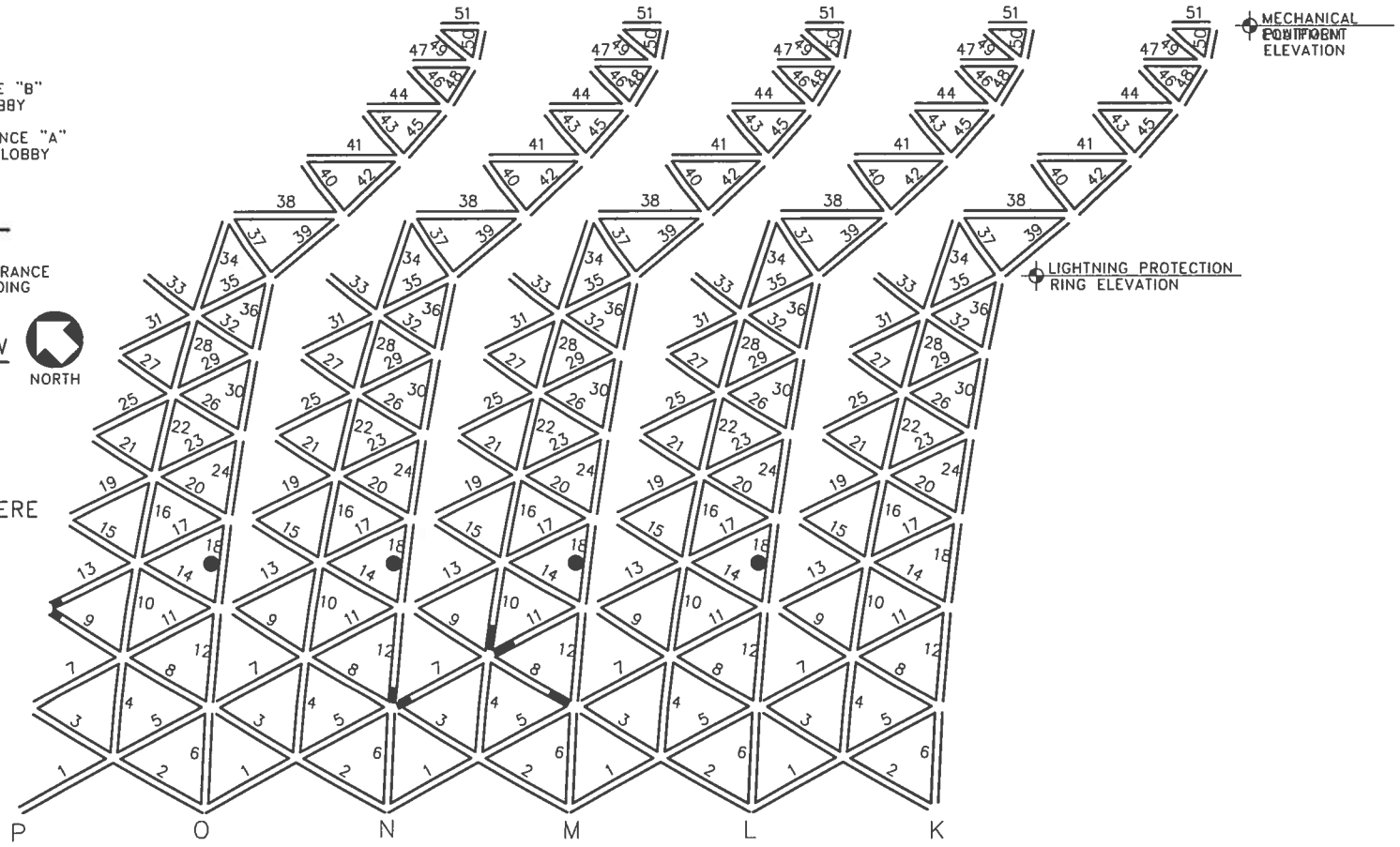


KEY – SHOW DOME PLAN VIEW

NORTH

KEY

- SPALL AT HUB
- SPALL/CRACK ELSEWHERE
- MOLD/MOSSY GROWTH (MINOR)



CONCRETE FRAME EVALUATION – SHOW DOME SEGMENTS K–P

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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MILWAUKEE COUNTY

EXHIBIT SD 9

$DATE$
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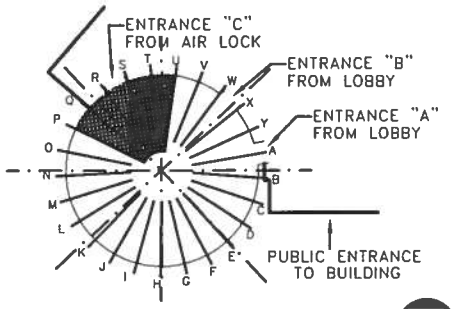
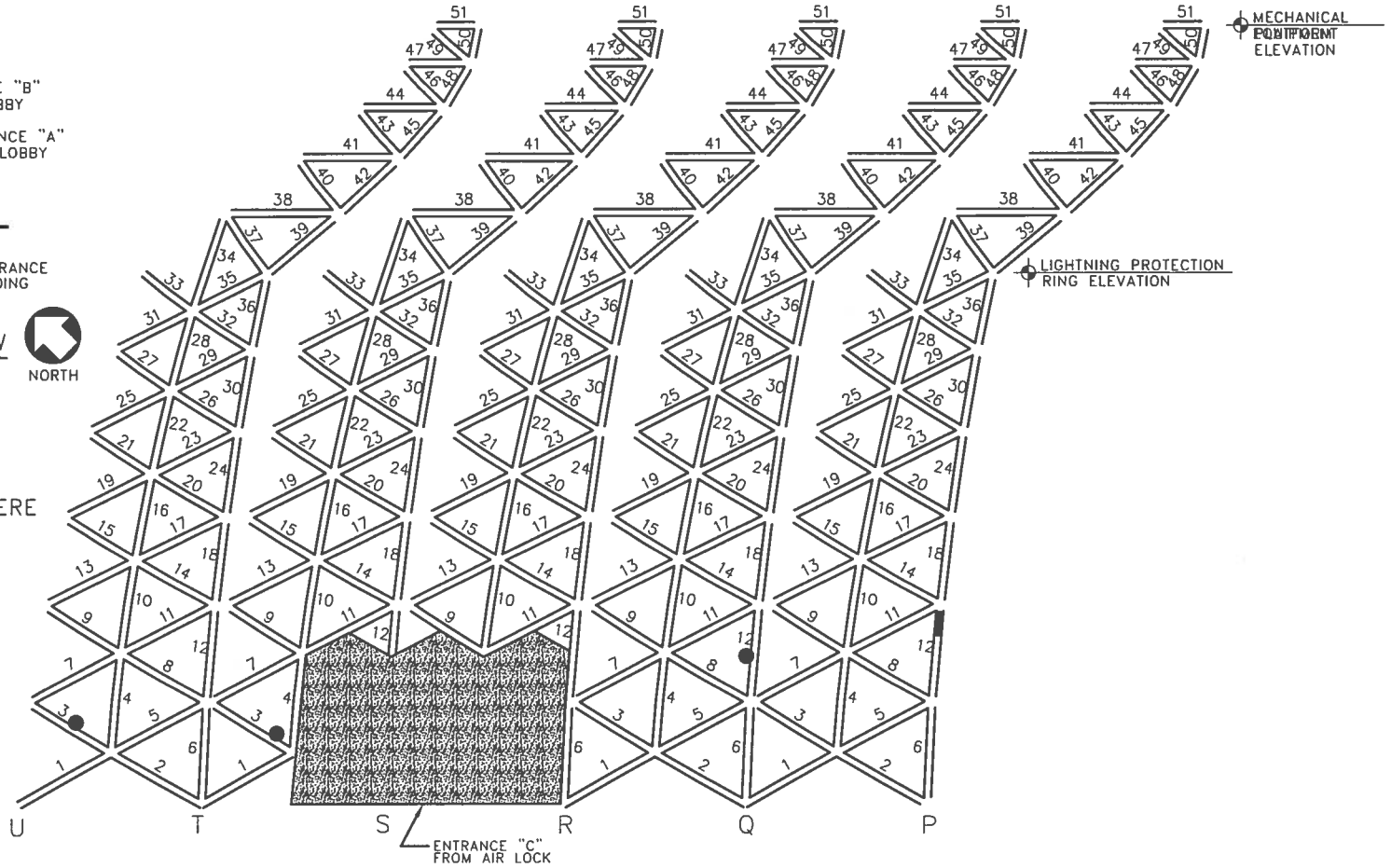


KEY – SHOW DOME PLAN VIEW

NORTH

KEY

- SPALL AT HUB
- SPALL/CRACK ELSEWHERE
- MOLD/MOSSY GROWTH (MINOR)



CONCRETE FRAME EVALUATION – SHOW DOME SEGMENTS P–U

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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MILWAUKEE COUNTY

EXHIBIT SD 10

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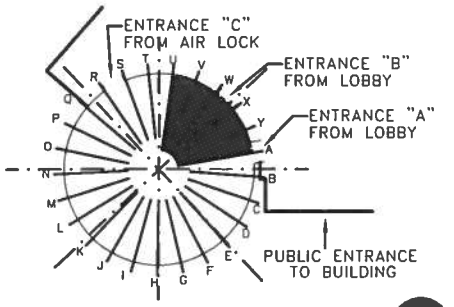
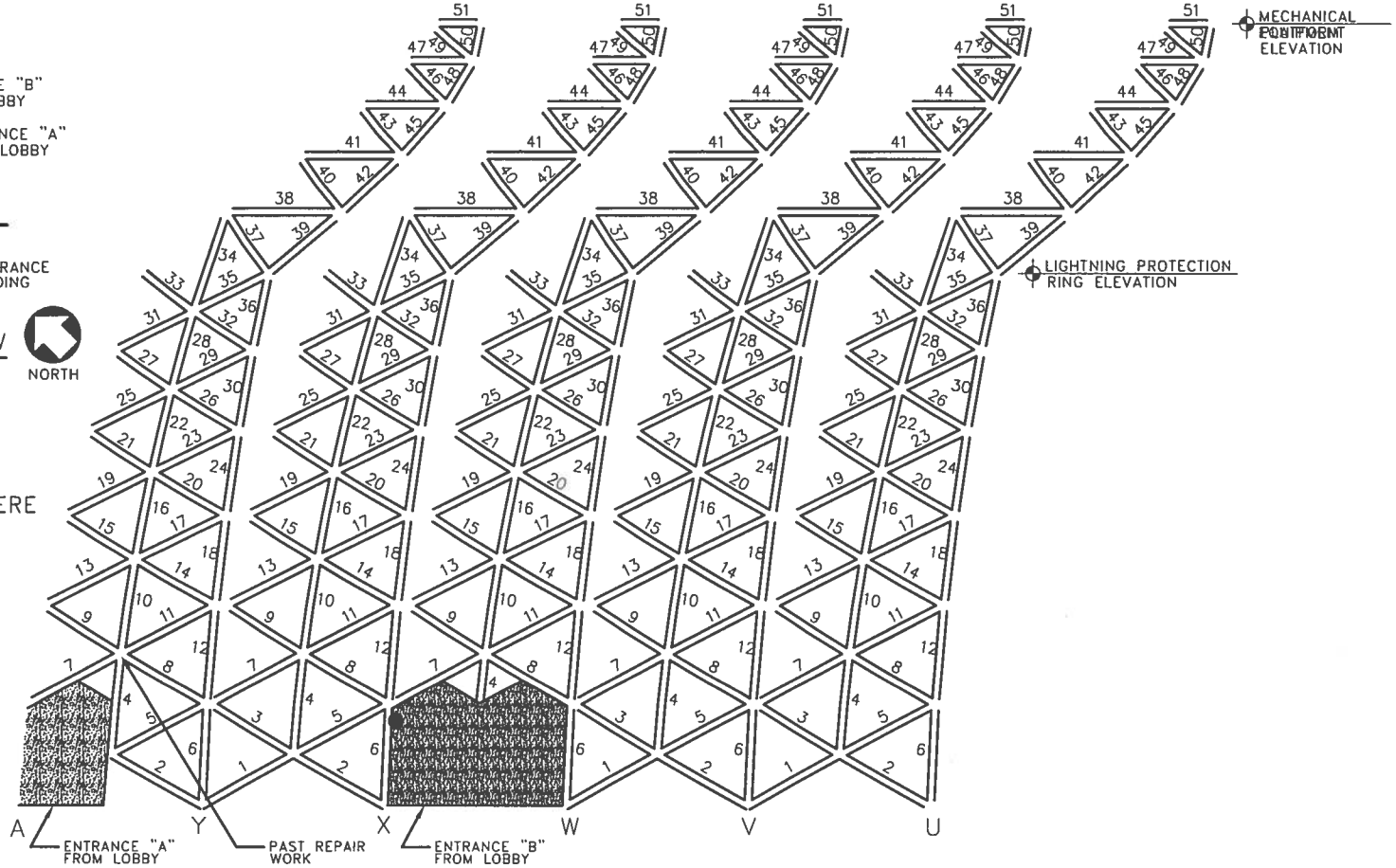


KEY – SHOW DOME PLAN VIEW

NORTH

KEY

- SPALL AT HUB
- SPALL/CRACK ELSEWHERE
- MOLD/MOSSY GROWTH (MINOR)



CONCRETE FRAME EVALUATION – SHOW DOME SEGMENTS U–A

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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MILWAUKEE COUNTY

EXHIBIT SD 11

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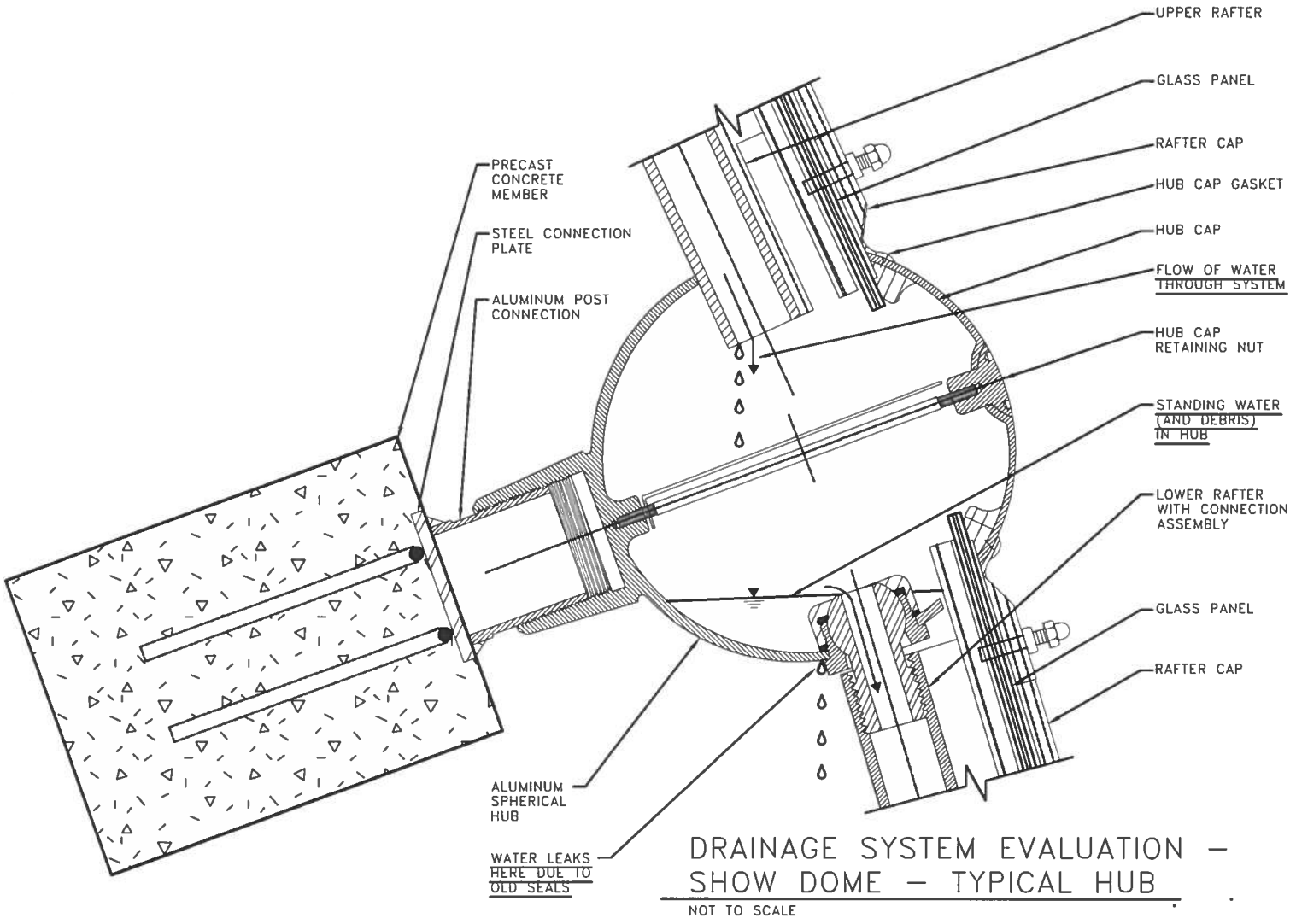

DRAINAGE SYSTEM EVALUATION – SHOW DOME – TYPICAL HUB

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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MILWAUKEE COUNTY

EXHIBIT SD 12

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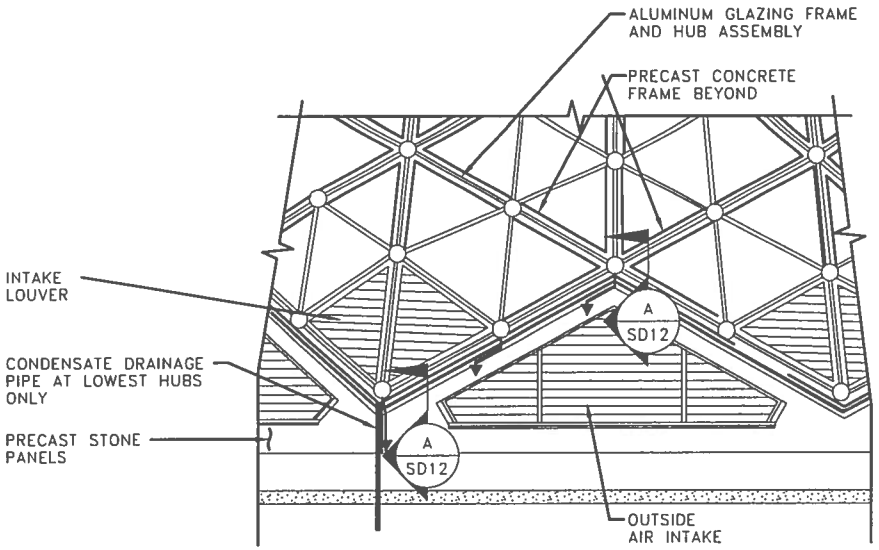
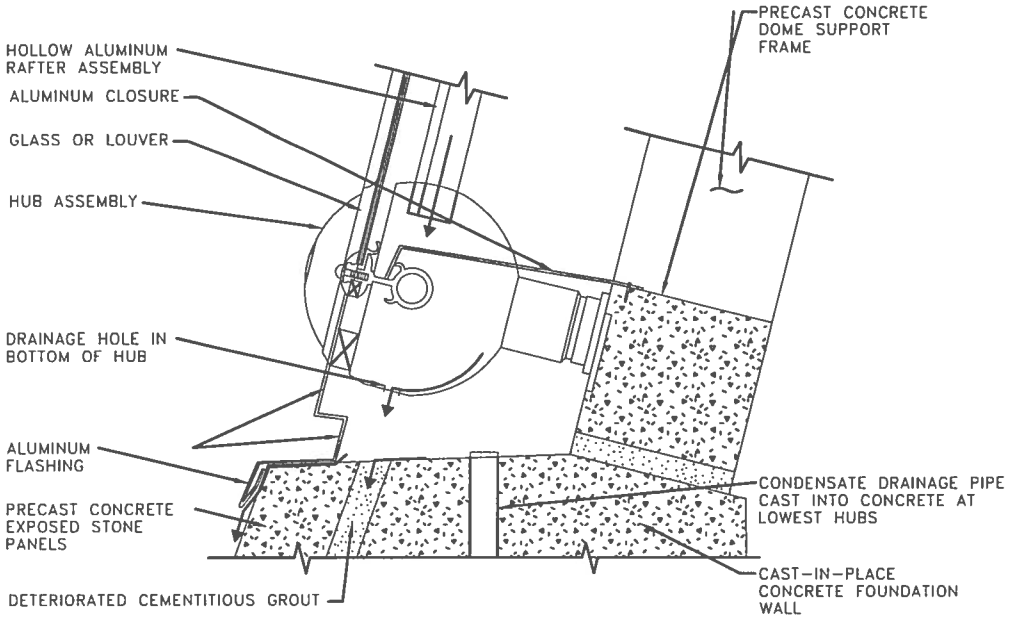


TYPICAL EXTERIOR ELEVATION



DETAIL A AT BASE FLASHING

KEY

→ CURRENT CONDENSATE MOISTURE PATH

DRAINAGE SYSTEM EVALUATION – SHOW DOME – BASE FLASHING

NOT TO SCALE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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SHOW DOME FACADE EVALUATION
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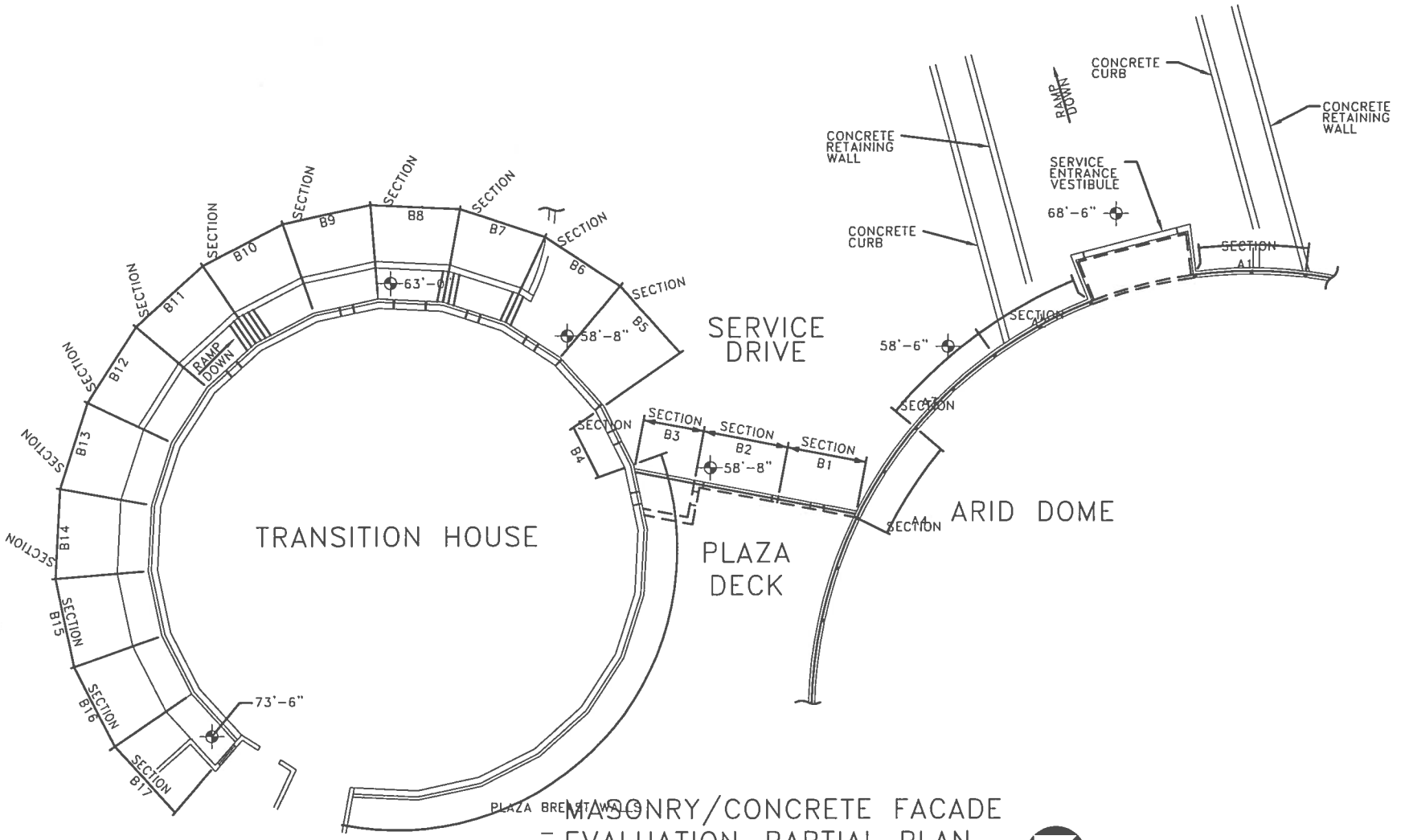
MILWAUKEE COUNTY

EXHIBIT SD 13

$DATE$
$TIME$
$FILE$



MASONRY/CONCRETE FACADE EVALUATION–PARTIAL PLAN

NOT TO SCALE

REVISION #1 – JUNE 8, 2007

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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SHOW DOME FACADE EVALUATION
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MILWAUKEE COUNTY

EXHIBIT SD 14

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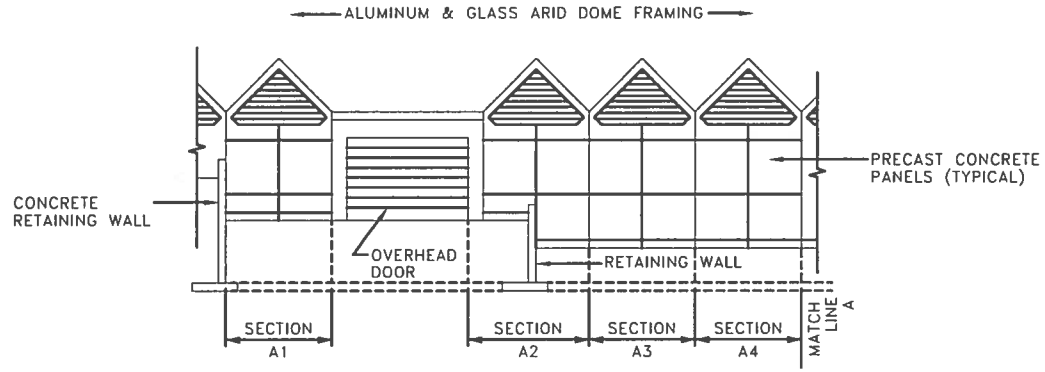
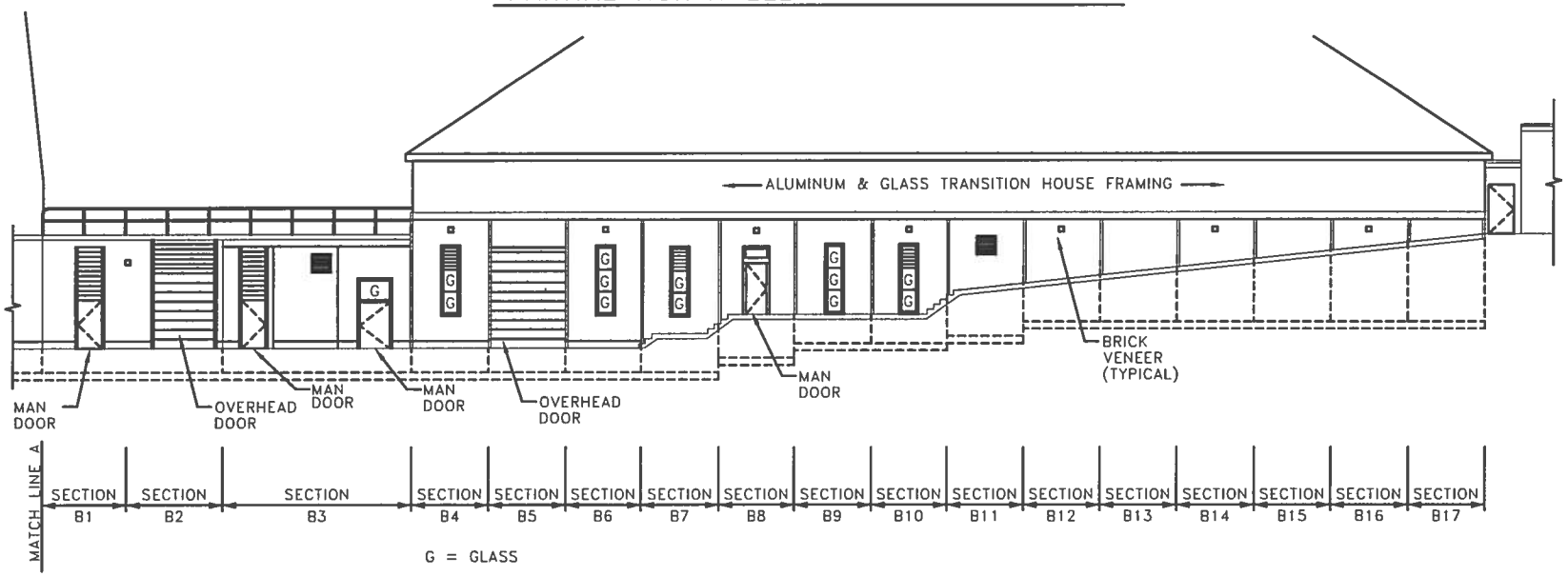


PARTIAL NORTH ELEVATION – ARID DOME



PARTIAL NORTH ELEVATION – TRANSITION HOUSE

PROJECT NO.: 20060268.00	DATE: JUNE 8, 2007	BY: BLM	PROJECT MGR.: MJR	SCALE: NTS	FILE:

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MITCHELL PARK CONSERVATORY
SHOW DOME FACADE EVALUATION
DEPARTMENT OF TRANSPORTATION AND PUBLIC WORKS
MILWAUKEE COUNTY

EXHIBIT SD 15

$DATES
$TIMES
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